

Office of Commercial Space Transportation

[Notice 95- ]

[Docket 50324]

Commercial Space Transportation; Grant of Petition for Waiver of Safety Criterion for METEOR Reentry Vehicle System

AGENCY: Office of the Secretary; Office of Commercial Space Transportation, DOT

ACTION: Notice.

SUMMARY: Pursuant to 49 U.S.C. Subtitle IX, ch. 701, formerly the Commercial Space Launch Act of 1984, as amended, and the Department of Transportation Licensing Regulations, the Department of Transportation (the Department) has been evaluating a proposed commercial reentry vehicle system as part of the first application for a license to place a reentry vehicle into space. EER Systems Corporation, the operator of the proposed reentry vehicle system, has petitioned the Department for relief from the first of three safety criteria against which its vehicle is being assessed. The Department has determined to waive the accuracy and reliability criterion in light of the applicant's proposed operations and that doing so will not jeopardize public safety. This Notice sets forth the basis for the Department's determination to grant the petition.

FOR FURTHER INFORMATION CONTACT: Ronald K. Gress, Deputy Associate Director for Licensing and Safety, Office of Commercial Space Transportation, U.S. Department of Transportation, 400 Seventh Street SW., Washington, DC 20590 (202) 366-2929.

## SUPPLEMENTARY INFORMATION:

### Background

The Department of Transportation's (the Department) Office of Commercial Space Transportation (Office) is evaluating the first commercial reentry vehicle system, known as METEOR (Multiple Experiment to Earth Orbit and Return), to determine whether it may be launched into space. The Office is conducting its review as part of the Department's responsibility to license and otherwise regulate commercial space launch activities under 49 U.S.C. Subtitle IX, ch. 701--"Commercial Space Launch Activities," formerly the Commercial Space Launch Act of 1984, as amended. Under 49 U.S.C. Subtitle IX, ch. 701, the Department has broad authority to determine whether the launch of an otherwise unlicensed payload, such as a reentry vehicle system, should be prevented because the launch would jeopardize public health and safety, safety of property, or any national security or foreign policy interest of the United States (49 U.S.C. 70104(c)). The Office is the Secretary's designee for carrying out the Department's mandate under the statute.

### OCST's Payload Determination Process

The Office's approach to evaluating the first commercial reentry vehicle system is described in two Notices previously published in the Federal Register (57 FR 10213-10216, published March 24, 1992; and 57 FR 55021, published November 23, 1992). Under that approach, the applicant or operator of the reentry vehicle system is required to apply for and obtain a favorable payload determination, consisting of: (i) a vehicle safety approval (VSA), whereby the applicant demonstrates that its integrated system is capable of being operated safely, and (ii) an operations review approval

(ORA), whereby the operator demonstrates its capability to operate the system safely.

Both approvals (VSA and ORA) are necessary to obtain a favorable payload determination.

The first Notice set forth the three criteria against which the COMET (COMmercial Experiment Transporter) reentry vehicle system would be assessed for purposes of obtaining a VSA. The latter Notice set forth the Office's intent to issue a single license authorizing the launch into space of the COMET reentry vehicle system, subject to, among other things, a favorable payload determination for the reentry vehicle system. Although the three criteria enumerated by the Office in the first Notice were developed in response to the COMET Program, which has since been discontinued, they are equally applicable to the pending application for METEOR.\*

EER Systems Corporation (EER) is proposing to operate and reenter the METEOR reentry vehicle system and has applied to the Office for a payload determination. By letter dated May 1, 1995, EER petitioned the Office requesting relief from the probability of accuracy criterion (Criterion 1) enumerated in the March 24, 1992 Notice.

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\* The COMET Program, as originally administered, was suspended in May 1994, when NASA determined not to augment a grant to the Center for Space Transportation and Applied Research (CSTAR), which was responsible for procuring the COMET mission. Nearly a year later, EER Systems Corporation (EER), one of the original participants in the COMET Program, advised the Office that it had taken over the COMET Program and would be responsible for the entire program, including the reentry. The spacecraft, originally developed by Space Industries, Inc., as part of the COMET Program, has been renamed METEOR.

## The METEOR Program

Under the METEOR Program, EER is proposing to launch the METEOR reentry vehicle system to low earth orbit using its newly-developed Conestoga launch vehicle. The Conestoga will be launched from NASA's Wallops Flight Facility, Virginia. EER is currently authorized to launch the Conestoga launch vehicle under License No. LLS 94-030. The authorization to launch is conditional upon issuance by the Office of final mission approval, including a favorable payload determination, for the METEOR reentry vehicle system.

The METEOR Program is similar to COMET. EER is proposing to launch METEOR to a 40.5 degree inclination low earth orbit (approximately 250 nautical miles) where it will remain on orbit for approximately 30 days for long duration microgravity experiments. Upon command from EER ground personnel, the reentering portion of the system (the reentry vehicle) will separate from the service module, its retromotor will activate, and the reentry vehicle will reenter along a ballistic trajectory to a designated landing site on earth. The reentry vehicle is smaller than the Mercury capsules used to return astronauts to earth in the early years of the manned space program, weighs about 730 pounds and is roughly three feet high by 52 inches in diameter at its widest point. The reentry vehicle is unguided; however, its ability to land within the designated site is affected by several factors determined immediately preceding initiation of reentry, including pointing accuracy, timing of the retroburn, and duration of the retroburn. Upon descent, a parachute is released to assure a soft landing. The service module will remain on orbit and continue to support microgravity experiments for approximately 130 days or more. The service module's

orbit will eventually decay and it will reenter the earth's atmosphere, burning up during reentry and presenting no greater risk to public safety than other reentering orbital debris.

In a significant departure from the COMET Program, EER's proposal designates an oceanic landing site, whereas the COMET proposal had designated the Utah Test and Training Range, a 24 x 51 mile U.S. Government facility located in a sparsely populated area of Utah. EER is proposing to reenter the METEOR reentry vehicle in the Atlantic Ocean and has designated as its landing site an area that is 18.4 nautical miles wide and 87.1 nautical miles long, centered around a targeted mid-point approximately 85 miles off the coast of Virginia.

#### Vehicle Safety Approval Criteria

The three criteria enumerated in the March 24, 1992 Notice for the first COMET mission, and now METEOR, all of which would have to be satisfied under the Notice, are as follows:

1. The probability of the reentry vehicle landing outside the designated landing site shall not be greater than three in one thousand missions.

2. The additional risks to the public in the immediate vicinity of the landing site (i.e., the area within 100 miles of the designated landing site) shall not exceed the normal background risks to which those individuals would ordinarily be exposed but for the reentry missions. This normal background risk is characterized as: the probability of any casualty occurring within the 100-mile zone shall not exceed one in a million on an annual basis. In addition, the probability of any casualty occurring within the zone shall not exceed one in a million for a single mission.

3. The additional risks to the general public beyond the 100-mile zone around the designated landing site, and to property on orbit, shall not exceed normal background risks to which the public would ordinarily be exposed but for the reentry

missions. This normal background risk is characterized as: the probability of any casualty occurring shall not exceed one in a million on an annual basis. In addition, the probability of any casualty occurring in the area that is both outside of the designated landing site and the 100-mile zone around the site shall not exceed one in a million for a single mission.

The March 24, 1992 Notice also provides supporting rationale for the criteria and explains their separate but interrelated safety objectives generally as follows:

- Criterion 1 is intended to assure reliable, accurate, incident-free reentry operations in order to foster public acceptance of commercial space transportation and minimize public exposure to risk. Criterion 1 assumes nominal pre-reentry operations conditions and addresses factors that affect accuracy after reentry is initiated. In its petition, EER has requested that OCST waive this criterion.

- Criterion 2 is intended to limit risks to the population that believes it may be more exposed to hazards resulting from commercial reentry operations because of their proximity to the designated landing site and to ensure they face no greater risk from commercial reentry operations than ordinary background risk. Criterion 2 becomes most relevant in the event of a system error or failure that causes a deviation from the vehicle's planned trajectory.

- Criterion 3 is intended to limit risks to the general public to ensure it, too, faces no additional risk beyond ordinary background risk as a result of commercial reentry activities. Criterion 3 addresses the risks posed by an essentially random reentry as a result of a major system failure during the reentry process.

As stated in the March 24, 1992 Notice, the criteria acknowledge that some

hazards, and therefore risks accompany the proposed reentry activity. The criteria reflect those hazards reduced to acceptable levels of risk. Through the criteria, the Office has established a level of acceptability comparable to that employed in other safety regulatory regimes, such as those administered by the Environmental Protection Agency, and consistent with risk thresholds utilized by Federal launch ranges as part of range safety.

Since early 1992, when the criteria addressing the COMET Program proposal were established, the design of the reentry vehicle system and the proposal to reenter it have evolved and matured. These developments have allowed the Office to assess specific aspects of reentry risks and their impact on public safety with greater clarity.

The three criteria are intended to address the risks to public safety that result from a human-induced reentry. For the majority of its mission, the risks presented by the METEOR reentry vehicle system are the same as those presented by other space payloads. It is the fact that the METEOR reentry vehicle is operated so as to land at a designated landing site and designed to withstand the stress of reentry that raises the potential of risk to public safety. Accordingly, in evaluating whether METEOR satisfies the criteria, the Office considers only human-induced or intentional reentries. The Office has determined that a human-induced reentry occurs when reentry is intentionally initiated upon command from ground personnel and the vehicle returns to earth within one orbit. The Office believes that there should be a direct relationship between initiating reentry and the reentry event itself for it to be considered human-induced or intentional. If the vehicle does not reenter upon command within one orbit, the direct relationship is broken and the vehicle remains on orbit as any other payload.

A malfunctioning vehicle that remains on orbit and then reenters the atmosphere as a result of orbital decay or other intervening events has not completed a human-induced or intentional reentry and the criteria

do not apply.\*\* Thus, the Office considers only those system failures or nominal system variations that may occur during the course of a "human-induced" or intentional reentry in assessing METEOR's ability to meet Criteria 1, 2 and 3.

#### Petition to Waive Criterion 1

EER's petition requesting relief from Criterion 1 is based, in part, on its misunderstanding of performance-based criteria. In establishing performance-based criteria for COMET, the Office stated its belief that, unlike design standards, "performance-based criteria allow the maximum flexibility in developing a safe and cost-effective product. The Office further believes that performance-based criteria enhance the public interest by encouraging innovation and technology development. This environment promotes safe space transportation services at lower cost and helps assure that customers' needs are addressed." (57 FR 10213, 10215)

In its petition, EER asserts, among other things, the difficulty of using performance-based standards to demonstrate reliability in the absence of flight performance history. EER further maintains that satisfying Criteria 2 and 3, without Criterion 1, would be sufficient to ensure that public safety is not compromised. EER suggests that Criterion 1 affords no additional protection to the public beyond that provided by satisfying Criteria 2 and 3.

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\*\* Even if an operator attempts an intentional reentry, it may fail for a number of reasons. METEOR includes a number of built-in fail-safe systems that automatically terminate the reentry sequence if certain conditions that would cause an inaccurate or otherwise unsafe reentry are detected. In addition, a system required for reentry to proceed could fail, leaving the reentry vehicle on orbit for more than one orbit. In both instances, there has not been a human-induced reentry and the spacecraft assumes a status essentially equivalent to other objects left in space. In the Office's assessment of the vehicle, neither of these failure scenarios are considered in

determining whether the criteria have been met.

Although the Office disagrees with EER's characterization of performance-based standards, the Office has evaluated whether Criterion 1 may be waived for the METEOR reentry mission without jeopardizing public safety. The Office undertook this evaluation because it is consistent with the Department's statutory mandate to issue a favorable payload determination allowing METEOR to be launched for its intended reentry mission if the Office finds that the proposed mission can be conducted without jeopardizing public safety and U.S. national interests.

In conducting its evaluation, the Office considered the relationship between accuracy (Criterion 1) and public safety. While accuracy contributes significantly to assuring public safety and is important to developing public and consumer confidence, the Office considered whether there are circumstances in which intentional reentry can occur and public safety is assured without the demonstrated level of accuracy required by Criterion 1. Next, the Office considered whether these circumstances would, in fact, occur in carrying out the METEOR reentry mission. Finally, the Office considered whether, if Criterion 1 is waived, additional measures are appropriate to ensure that public safety is protected.

The Office has determined that there are circumstances in which the relationship of reentry vehicle accuracy to public safety becomes less significant. The three criteria were developed to have a mutually reinforcing effect on public safety. Although their objectives are interrelated, they were designed so that Criterion 1 can compensate if the ability of the reentry vehicle system to meet Criteria 2 and 3 is marginal, and vice versa. Stated another way, the probability of a casualty is, among other things, a function of the probability of missing the landing site. Other

contributing factors include the size and mass of the vehicle upon impact, its contents, and the population distribution in the area where the vehicle could impact if it missed the designated landing site. For example, if a reentry vehicle is extremely small and contains no hazardous materials, the probability of a casualty during a reentry would be quite low, even if the vehicle had little probability of landing in the designated site. However, the probability of a casualty could be high if that vehicle were quite large, contained explosives or hazardous materials, or if the vehicle was likely to impact in a densely populated area if it missed the designated landing site. Thus, under certain conditions, it may be possible to relax or eliminate an accuracy criterion if the risk to public safety remains within acceptable levels. They are as follows:

- If it can be shown that there are well-defined areas within which the vehicle is most likely to land if it misses the designated landing site, and that the risk to the population within these areas is within acceptable limits;

- If it can be shown that the vehicle, if it misses the designated landing site, is unlikely to survive reentry or is likely to reenter in a condition that presents little risk to exposed populations because it contains little mass, no hazardous materials, or both;

or

- If it can be shown that risk mitigation measures (e.g., public notices or warnings, emergency response plans) can be implemented to limit the risk to exposed populations to acceptable levels in the event the vehicle misses the designated landing site.

To determine whether any of these circumstances will exist for METEOR, the Office analyzed a broad range of failure scenarios that may occur when a human-

induced or intentional reentry occurs. In conducting risk scenario analyses, the Office used a conservative approach in that it did not consider the mitigating effects of a parachute system built into the reentry vehicle to soften landing impacts.

In the event of a minor system error or failure, such as one that alters the aerodynamic characteristics of the vehicle as it descends, the Office determined that the dispersion area or "footprint" within which the vehicle would be expected to land would most likely be enlarged, shifted, or both. The vehicle would still land in the general vicinity of the landing site, that is, within the 100-mile zone. Given EER's designated landing site in the Atlantic Ocean, the 100-mile zone around the designated landing site is principally ocean area or some sparsely populated land areas. Based on dispersion, vehicle break-up and other risk analyses, the Office determined that risk to public safety would remain well within the threshold of normal background risk identified in Criterion 2.

In the event of a major system failure which causes a random reentry, such as severe misalignment of the vehicle during retroburn resulting in insufficient thrust to deorbit along the desired trajectory, the Office determined that the only population placed at risk would be those persons residing along the orbital path, or ground trace, of the final orbit. This area occupies a swath approximately 20 miles wide and extending approximately 3,000 miles beyond the designated landing site. The area is so limited because of the limited cross-range capability of the vehicle. Because of the inclination of the orbit and the designated landing site, most of this ground trace is over uninhabited broad ocean. The effect of alignment or burn errors increases very rapidly with the magnitude of the error, so that if the METEOR reentry vehicle travels

beyond 3,000 miles from the intended landing site it will remain in space for more than one orbit. Although the ground trace includes some areas of the United States, the likelihood of landing on land is small, given that most of the ground trace is over ocean. Moreover, the areas of the United States in which the reentry vehicle could land are relatively sparsely populated and, based on dispersion, vehicle break-up and other risk analyses, the Office found that risk to public safety would remain within the threshold of normal background risk identified in Criterion 3.

A gross failure that causes the vehicle to remain on orbit for more than one orbit after the intended reentry need not be considered under the vehicle safety criteria. Nevertheless, the Office evaluated the risks associated with a gross failure and determined that risk to public safety still would remain well within the threshold of normal background risk identified in Criterion 3. In fact, the Office determined that an intact reentry module that impacted on earth or the reentering debris from the reentry of the entire vehicle system (the reentry vehicle joined to the service module) would be smaller than, and therefore pose less risk than, the debris believed to survive the reentry of large abandoned satellites or spent upper stages of Titan, Atlas, and Delta launch vehicles.

Accordingly, the Office has determined that there are circumstances in which intentional reentry of METEOR can occur and public safety will be assured without the demonstrated level of accuracy required under Criterion 1, and that these circumstances do, in fact, exist for METEOR. There are well-defined areas within which the reentry vehicle is most likely to land if it misses the designated landing site. The risk to the population within these areas falls within acceptable limits. The small

size and mass of the reentry vehicle and the lack of hazardous materials on the vehicle would minimize the potential risk to public safety if it misses the designated landing site. Moreover, under certain failure scenarios, the reentry vehicle would break up and reenter in small bits of debris, much of which would likely burn up as it passes through the atmosphere.

The Office has concluded that, in light of the performance characteristics of the METEOR reentry vehicle, the proposed mission including an oceanic landing, the small size of the reentry vehicle and the absence of hazardous materials on the reentry vehicle, public safety and U.S. national interests would not be jeopardized if the landing accuracy (Criterion 1) is waived. However, as a condition of the waiver, the Office is requiring that EER implement a public information communications plan under which the affected public would be informed of the reentry activity, including the estimated time and location. EER must also have in place an emergency response plan whereby local officials may be notified in the event of an off-site landing and vehicle recovery can be conducted effectively.

In addition, NASA's Wallops Flight Facility has agreed to provide range safety support for the reentry which includes coordination, through appropriate Federal agencies, of notices to air and marine traffic in the vicinity of the designated landing site to minimize risks during the reentry.

Accordingly, the Office has determined that, for METEOR, Criterion 1 may be waived and the relief requested in EER's petition is granted. \*\*\*

Issued in Washington, DC, this \_\_\_\_\_ day of \_\_\_\_\_, 1995.

Frank C. Weaver, Director  
Office of Commercial Space Transportation

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\*\*\* At the time the COMET Program was suspended, a petition submitted by Space Industries, Inc., as applicant for a payload determination, was pending. No final action was taken in light of the decision to discontinue the COMET Program. In granting the petition for METEOR, the Office has made no determination as to whether doing so would have been appropriate for COMET or any other reentry vehicle system or mission.